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Physical Rehabilitation

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As the word "Rehabilitation" has become familiar through its use, I decided to check its meaning in the Concise Oxford Dictionary. The dictionary lists the word as meaning "return to previous state after lapse or cessation". But I was interested to find there was a close association between the word "rehabilitate" and other similar words such as "rehandle", "rehash", and "rehear".

It struck me that these words represent processes that are an integral part of the total concept of the word "rehabilitation". So often we, as physicians, do not consider the total meaning and accept a partial definition which may be expressed as the ability "to utilize or realize the potential working capacity of a disabled person inside the limits of his physical (and mental) resources".[1] Only when we have rehandled a problem, rehashed the case of doubtful diagnosis with our colleagues, or reheard the sad story of just how terrible a particular patient is as the result of the injury, which long since has failed to leave its imprint, and neither physical, radiological or consultant examination reveal a clue, do we consider what physical rehabilitation has to offer. Then at such a late date we attempt to gain something from nothing.

When should we begin this process? By considering the phases through which illness or injury pass, a time element is brought forward. In the "Triology of Treatment" are the phases—

(1) *Immediate*—when we are faced with first-aid emergency treatment and the preservation of life.
(2) Definitive phase—when elective surgical or definitive medical techniques are introduced, necessitating a plan—purposeful thinking and skill.
(3) *Active convalescent* or physical rehabilitation phase—which follows close upon the definitive phase.

It is the gap between the definitive and convalescent phase, allowed too often to be prolonged by procrastination of one type or another, which must be closed.

In spite of all the ancillary tools which we have at our disposal, the key to successful physical rehabilitation after injury lies in the use of properly dosed and supervised therapeutic exercises. These alone will do much to lessen the length of disability after injury and if introduced as early as is possible, will narrow the gap between the second and third phases of treatment.

It is on some aspects of therapeutic exercise that I, therefore, wish to devote my time and to demonstrate only a few of the common procedures which may be of help and value in the ongoing treatment. They may be used individually or in groups, and integrated successfully into any rehabilitation program.

A most necessary part of the exercise program depends on the patient's will or desire to get well. We must, if at all possible, stimulate and direct this aspect of treatment. If we have a patient whose attitude is one which can be described as "Let's just see you get me well before I think I am ready," even the following program will be of little use. The psychological attitude of our patient must be molded so that full acceptance and indulgence in an exercise program will be the result.

Providing the will to get well is present, or successfully stimulated, the physiological objectives of an exercise program are:

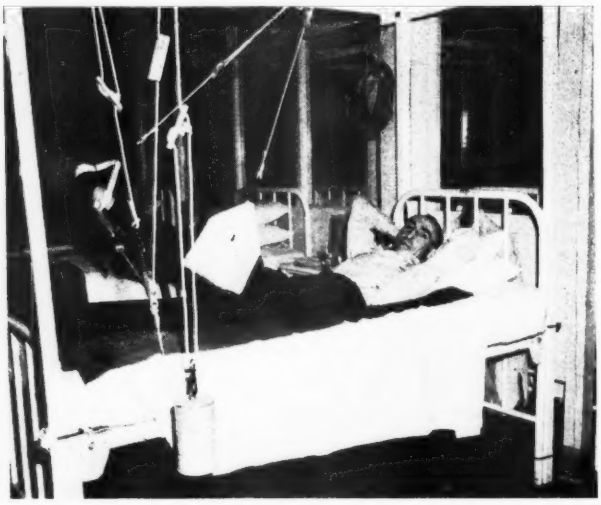
(1) To prevent physical deconditioning;
(2) To maintain or increase muscle strength or power;
(3) To maintain joint mobility or mobilize joints;
(4) To instruct in muscle retraining and coordination.

In reaching the prescription of exercise considering these objectives, muscle function must be assessed. According to Hans Kraus[2] it can be differentiated into three basic qualities:

(1) Power—which is the ability of a muscle to contract;
(2) Elasticity—ability to give up contraction or yield to passive stretch;
(3) Coordination—ability to cooperate with other muscles in proper timing.

Accepting these qualities, then it is possible to explain a deficiency of muscle action as a consequence of a loss or disturbance of one or all of them. While the seat of pathology may be different in each case the common objectives will be the restoration or improvement of the quality impaired. Thus in a weak muscle, our aim is increased power; the non-elastic, or muscle in spasm our aim is one of increased elasticity; in incoordination, the re-establishment of a proper pattern.

Knowing the defective qualities for which to look, we then apply this knowledge to the individual muscle or muscle group and direct the proper exercise for improvement.



The types of exercise which may be used are:

1. Passive—(nerve injury, etc.)
   —Forced (manipulation)
2. Active supported—the elimination of gravity by slings, water, therapist, etc.
3. Active—Where patient is capable of muscular control, including static isometric contraction.
4. *Active Resistive*—Active by weights or manual by therapist, where motion is resisted. *Power* building by progressive resistance regime, such as is used in the Delorme and Oxford techniques.
5. *Active Assisted*—in which the therapist or the patient (auto-assisted) helps passively to increase active range.

In the traumatic case particularly, and in the office direction of the patient, active and restive types of exercise will be the anchor of rehabilitation therapy.

We have then given (1) the physiological objectives, (2) the basic qualities of muscle, and (3) the types of exercise techniques which may be used.

Our next problem to be faced is the use in a therapeutic manner, with these basic concepts in mind.

To Prevent Physical Deconditioning:

The bedfast patient at home or in hospital will usually be quite inactive, even for his lesion, and, unless special attention is given to exercise, a gradual loss of all the basic qualities of muscle in a generalized manner may develop. In order to prevent this, we advise the introduction of a program of active exercise within his capabilities. He will be stimulated to feel, in so doing, that he has an active part in the process of getting well instead of a passive dependent attitude.

This program includes an outline of an exercise pattern in a regularly timed and orderly fashion. Instructions are given to put all free joints through as full a range of movement as is possible to prevent stiffness, weakness, stimulate circulation, maintain elasticity and coordination of the unaffected members. This program should include the thoughtful movement of the parts twice daily for fifteen minutes, beginning at the feet and working to the head, using reasonably slow effective movements.

Deep control breathing should be practiced to prevent pulmonary hypostasis and to stimulate the venous return by variation in negative pressure of abdomen.

To Maintain Muscle Strength and Power:

This is in particular reference to surgical cases and will pay dividends in those cases treated in plaster. Satisfactory immobilization is pre-requisite.

If it is possible prior to elective surgical procedures a period of training under supervision is beneficial. With proper immobilization for surgical lesion, certain joints are, or may be, left free. Who has not seen the result of stiffness and disability following unnecessary encasing of M.P. joints of hand, stiff toes, or stiff shoulders from not adhering to this principle.

The affected area is assessed as to the underlying pathology, then a regime of exercise, not twiddling, outlined. These exercises should be done hourly for a minimum of five minutes, and should include at least 10 movements. As we are all fundamentally lazy and there will be a period of immobilization, encouragement, supervision and demonstration are essential to keep up morale. Each visit to hospital or office includes a demonstration by the patient of the exercise in which he has been instructed.

By preventing deconditioning and maintaining muscle strength and power, joint mobility and mobilization will be accomplished to its maximum and coordination easily obtained. The above will result in definite psychological benefit to your patient, and the end-point will be a reduced period of non-productive existence.

Exercise is the keynote of physical rehabilitation and if properly prescribed and supervised it will pay dividends.

With the assistance of Mr. T. Wells, Chief Remedial Gymnast, Convalescent Centre, Malton, a demonstration of three exercise techniques has been given.

(a) Quadriceps setting with gravity resistance.
(b) Deep controlled breathing.
(c) Hyperextension exercise for back.

These will be forwarded on request.

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Noise

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Recently the problem of industrial noise and its effect upon hearing has received widespread attention in all types of professional publications. During 1951 many meetings were held at which the importance of the noise problem was emphasized. However, noise and its effect upon hearing is not new. During the 19th century reports dealing with deafness in boilermakers, railway men and weavers were published.

Today noise has received this increased attention due to its increasing presence. The expansion of industry during World War II with new high speed machines and increased production resulted in production of uncontrolled noise of increased intensity and frequency. During the war period only slight attention was paid to this problem. Since then, though, scattered investigations have shown that a problem does exist. The effect of noise on human behavior, health, work efficiency, and work output have been discussed by Kryter.[1] No attempt will be made here to include this phase of the problem.

Practically speaking, certain basic definitions are needed before a full discussion of the problem can be made.

Noise

Sound is defined as a wave motion in the air. Sound waves are set up by any vibrating body, they travel through the air at a definite speed, and if their frequency and intensity are within certain ranges, they produce the sensation of hearing. Noise is the common term used to denote unwanted sound.

All sound waves travel at a constant speed of approximately 1120 feet per second or 763 miles per hour. Their speed is the same regardless of the pitch or loudness of the sound.

Intensity

Sound energy is usually described in two ways. In considering a single sound wave traveling in a known direction, the measure of the amount of energy in the vibrating air particles is referred to as *intensity*. Imagine a single sound source radiating sound energy equally in all directions from the center of a sphere. The total sound energy passing through the entire surface of this sphere is equal to the sound energy developed at the source.

If we double the radius of our sphere the same amount of energy will still pass through the entire surface of this second sphere. However, the area of the spherical surface of the second sphere will be four times greater than that of the first sphere because this surface area varies as the square of the radius. Thus, the sound intensity at the larger sphere's surface will be one-fourth that found at the smaller sphere's surface. Likewise, tripling the radius would reduce the intensity to one-ninth. This relation is known as the inverse square law, which states that the sound intensity is inversely proportional to the square of the distance from the source.

The ear registers varying sound energy or intensity as varying loudness.

Frequency

Frequency is an indication of the pitch of a sound. The frequency indicates the number of complete vibrations the sound source makes each second. As the sound source also causes the air particles to vibrate at the same rate as the sound source, it can be said that frequency measures the number of vibrations of the air itself.

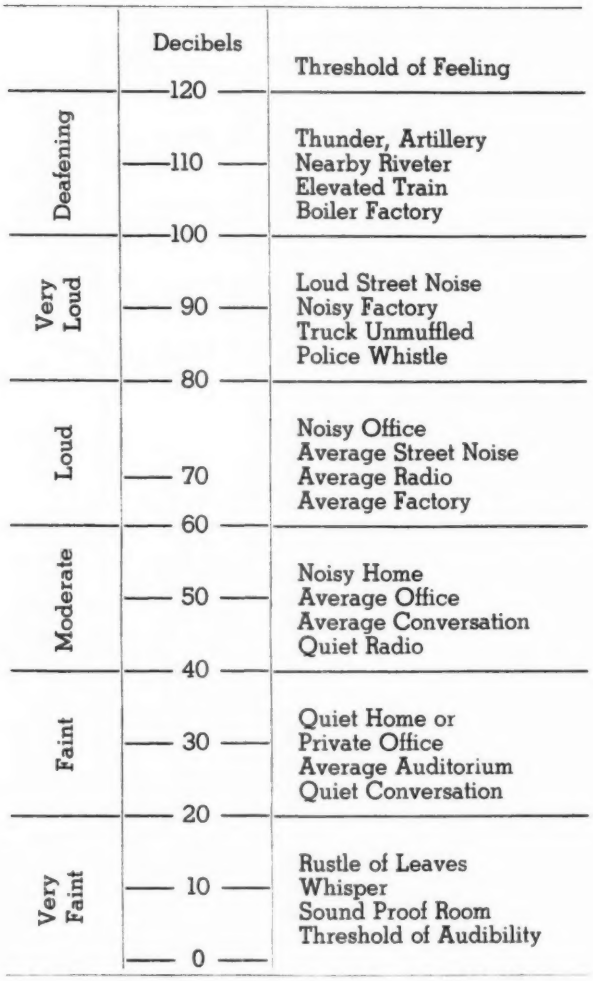
In acoustical work frequencies are laid out in octaves in the same manner as a piano keyboard. An octave is defined as the interval between any two sounds having a frequency ratio of 2 to 1. The most commonly used frequencies are 62.5, 125, 250, 500, 1000, 2000, 4000 and 8000 cycles. The frequency 250 cycles is approximately that of middle C on the piano while 4000 cycles is four octaves above middle C, which is the top note of the piano. This series of frequencies covers most of the range of frequencies in speech, music and noise.

Decibel

Measurements of hearing have shown that the normal ear is capable of receiving an incredibly wide range of sound intensities. The loudest sound the ear can hear without a sensation of pain has about one trillion times the intensity of the faintest audible sound. In order to handle this large range of intensities a unit termed decibel has been adopted. Actually decibels indicate the ratio between any two sound intensities, and is defined as 10 times the logarithm to the base 10 of that ratio. The energy flow of 10-16 watts per square centimeter has been adopted as an intensity of 0 decibels. A human ear a little more sensitive than normal could hear a sound of that intensity. It is sufficent for all practical purposes to only remember

A paper presented at the Interprovincial Conference of Industrial Physicians London, Ontario, October 9, 1952.

FIGURE 1



that decibels indicate sound intensity, and any sound level in decibels refers to an arbitrary zero standard.

Due to this logarithmic representation of sound levels it can be shown that doubling the intensity of any sound corresponds to an increase of approximately 3 decibels. Also a 1 decibel increase corresponds to an increase in intensity of approximately 26%.

Figure 1 shows the intensity level of common sounds on the decibel scale. The threshold of audibility at the bottom of the scale is the intensity level of the faintest sound the ear can hear. The threshold of feeling is the intensity level at which a sound is so loud as to begin to cause pain to the normal ear.

Hearing

The frequency and intensity of a sound produce the corresponding physiological sensations of pitch and loudness. High pitched sounds, such as whistles or treble notes of a voice, are high-frequency sounds, and low pitched sounds, which we describe as rumbles, roars, or base notes are characterized by low frequencies. The loudness of a sound depends on its intensity; the greater the intensity, the louder the sound.

The manner in which the ear responds to sound waves of different frequencies and intensities and converts them into sensations of hearing is quite complicated. Two sounds of the same intensity but of different frequencies do not necessarily sound equally loud, nor does one sound having twice the intensity of another sound appear twice as loud. Certain points are apparent in this respect of frequency and intensity, or pitch and loudness.

1. At low intensity levels, high frequency tones sound louder than low frequency tones of the same intensity.
2. At high intensity levels, all tones of the same intensity sound almost equally loud, regardless of their frequency.
3. At low intensity levels, a given change in intensity level produces a larger change in loudness at low frequencies than at high frequencies.
4. At high intensity levels, a given change in intensity level produces practically the same change in loudness regardless of frequency.

It is understood that besides intensity, frequency and distance, other factors such as period of exposure, individual susceptibility, age, character of surroundings and position of each ear with respect to the sound source influence hearing.

In general, the longer the duration of exposure to an abnormal noise source the greater the hearing impairment. There are obviously exceptions to this. Certain ones have been cited in the literature, where loss of hearing has resulted from a single exposure to explosive sounds of very high intensity.

Individuals have been shown to vary from ear to ear in their susceptibility to hearing loss. Differences also exist in the recovery rate for hearing loss. Certain authorities[2] feel that from 6 to 18 months is necessary before a final judgement regarding the true (non-recoverable) hearing loss can be determined accurately. This obviously presents certain legal complications. Wheeler[3] cites a recent industrial study of 175 persons exposed to very high noise levels. As many as 45% retained normal hearing in some instances after 10 years exposure. On the other hand, 23% displayed severe bilateral hearing loss after only a few months.

The influence of age on hearing is probably best shown by the figures obtained during the World's Fair Hearing Tests[4] and the San Diego County Fair Hearing Survey.[5] Figure 2 illustrates these findings. The major losses are found in the higher frequencies.

Room acoustics play an important part in the effect of noise upon hearing. Walls, ceilings, partitions and the like which reflect, enhance prevailing noise and

FIGURE 2

Frequency		440		880		1760		3520		7040	
Age	Fair	Male	Female	M	F	M	F	M	F	M	F
10–19	S.D.F. x	–0.3	0.2	–1.0	–0.1	–1.9	–0.1	–3.2	–4.1	–3.3	–5.3
	W.F. xx	1.0	0.5	0.3	0.2	–0.3	–1.1	–1.2	–4.4	–0.4	–3.6
20–29	S.D.F.	–1.3	–1.3	–0.7	0.7	0.4	–0.4	–3.8	–3.8	3.9	–3.9
	W.F.	0.0	0.0	–0.2	0.2	–0.1	0.1	2.0	–2.0	1.5	–1.5
30–39	S.D.F.	0.3	3.6	1.3	3.1	2.2	2.7	7.7	–0.7	6.5	–0.1
	W.F.	1.4	2.6	1.3	2.6	2.3	2.9	8.2	2.4	7.7	4.8
40–49	S.D.F.	1.3	5.3	2.4	4.3	6.0	5.2	13.2	0.7	13.3	3.6
	W.F.	3.7	6.0	4.5	5.8	7.0	6.7	17.7	7.8	16.8	11.9
50–59	S.D.F.	4.2	6.9	4.9	7.3	11.9	10.4	25.0	7.3	27.9	12.2
	W.F.	6.8	10.3	7.7	9.8	12.1	11.0	25.6	13.8	24.0	19.7

x San Diego County Fair xx World's Fair

aggravate damage. Also, the ear of the industrial worker who is subjected to incessant noises from all sides will be more affected than military personnel exposed to gunfire from a specific direction which they can turn away from.

Measurement of Sound

The measurement of sound level, (intensity-loudness) is done by instruments which meet the Z24.3 American Standards Association Code entitled "American Standards on Sound-Level Meters." Basically, these instruments are readily available, and are being used by industrial hygienists all over the country. Unless one is doing considerable research, the standard sound level meter with a Rochelle salt microphone will fit all one's needs.

Similarly, unless one is doing research, the octave band analyzer is best used for routine frequency (pitch) analyses. The common series of bands is 37.5-75, 75-150, 150-300, 300-600, 600-1200, 1200-2400, 2400-4800, and 4800-9600 cycles per second.

In using these two main field instruments the placing of the microphone is important. Normally in industrial hygiene work the microphone is placed in a zone which is occupied by a machine operator or other person.

Sound Level Standards

To date there seem to be few if any *accepted* codes, rules or regulations indicating the sound and frequency level below which one should keep the noise level to prevent hearing loss of industrial origin.

Extensive literature research relative to such standards was recently carried on by one of the leading industrial physicians in the United States.[6] Where individual levels of noise tolerance were stated they ranged from 75 to 100 decibels.

At the same time when frequency is considered, as it must be, a frequency limit type curve develops. Figure 3 indicates four such curves.

At the University of Michigan School of Public Health's inservice training courses on "The Acoustical Spectrum", Dr. A. Glorig stated, "In general, we positively know that intensities of 130 decibels or more are damaging in a relatively short time; that in most cases 120 to 130 decibels will produce damage in time; that in many cases 100 to 120 decibels will produce damage in time; that in highly susceptible cases 90 to 100 decibels will produce damage; and that intensities below 90 decibels will produce no damage."

Regarding ultrasonic frequencies, ordinarily transmitted through air, Parrach[7] stated that at present there is no evidence that these are a hazard to man. There is, however, a danger to workers coming in contact with machines generating these ultrasonic frequencies.

From the foregoing, it is apparent that considerable advance has been made in the matter of proposed standards. The values given thus far represent the judgment of a single or small group of investigators. Admittedly, these contributors are the persons with the greatest experience with the problem. However, a standard is *usually* developed only after it has been tested in a wide variety of actual work conditions. After such tests the standard then contains the element of practical application rather than a purely theoretical approach.

This is the point at which we are today. Theoretical standards are well formed, and field application is in process. When sufficient experience has been gained a final resolution of this problem can be made. Obviously, medical data along with field measurements are necessary before this entire picture will be completed. It is further apparent that some time will be required before sufficient data has been collected from which a basic opinion can be made.

Noise Control

Noise can be controlled to a degree by various methods. The first attempt at control should be aimed at the source. On any noisy machine all loose or rattling parts should be tied down by one method or another. The machine itself should be continually maintained in proper repair and kept in good adjustment. Where metallic impacts exist an attempt to substitute plastic or viscous materials should be made. In the stamping of metal parts there is excessive noise created. Within the past three weeks there appeared a newspaper article in our local press indicating the application of a resinous material as a stamping die in place of steel. This will obviously reduce this noise source considerably. We are still awaiting further information relative to this installation.

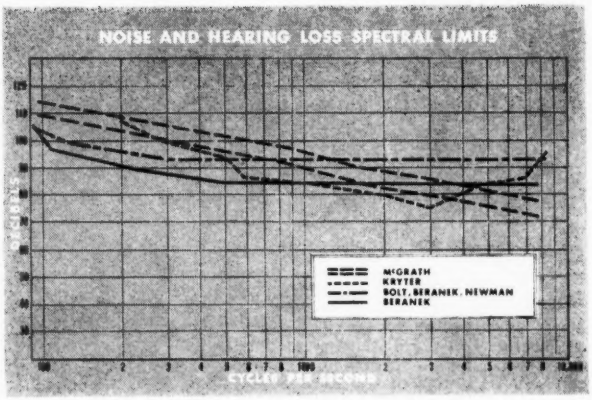
Machines can be mounted on resilient supports in an attempt to reduce low frequency noise and floor vibration. If practical, the machine should be redesigned for quieter operation. Substantial reductions in overall noise level can be achieved by such attention to the machine proper.

Another method of noise control is through shielding and segregation of noisy operations. In general it is best to group the noisiest machines in the same area, being sure to maintain as wide a spacing as possible between similar machines. In some instances, the noisiest operations can be placed in a separate room. In addition, absorbent lined booths can be built around the noisiest machines. Further aid to the general workroom can be obtained by erecting baffles to act as barriers against sound transmission in a given direction. These barriers are particularly effective in removing high frequency components.

The other major means of noise control, and probably the one you are most familiar with, is through sound-conditioning of a noisy area. Sound conditioning will eliminate excessive reverberation with resulting relief from prolonged exposure to noise impulses and increased ease of conversation. Good sound conditioning will eliminate excessive build up of intensity and most conditioning materials will efficiently filter out the high frequency noise components. Further, there will be a reduction in the spreading and diffusion of noise, with consequent decreased annoyance from distant noise sources and increased ease in distinguishing nearby individual noise sources.

The use of high speed fans and blowers in present day air conditioning or parts drying equipment sometimes create undesirable noisy conditions. One such unit which I am familar with had the exhaust pipe treated internally with acoustic deadening material and showed a decibel reduction of 3 to 4. As mentioned previously this is a reduction of approximately 50% in intensity.

FIGURE 3



Personal Protection

There are available on the market various types of ear protective devices. These take the forms of ear muffs, wax type plugs, rubber plugs, and even a plastic molded plug for the individual's ears. All of these to a degree attenuate noise. However, as with any personal protective equipment, the human factor is introduced which always can present the possibility of loss of your control program. Even under ideal conditions the best reduction to be expected in this direction is approximately 35 decibels.

Medically, data are needed regarding preplacement audiometric findings, and similar data are needed after various periods of exposure to known intensity and frequency noises. With the gradual accumulation of data of this type one will be able to more definitely define the workroom limits. The specific method of audiometric testing is a subject which has received considerable attention in the literature. I would refer you to these sources for information on that controversial subject.

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Problem Drinking in Industry

By R. G. Bell, M.D., Medical Director
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Twenty years ago it would have been difficult to find any industry dealing with problem drinking in other than a disciplinary fashion. Had it not been for two very important developments that came about in the nineteen-thirties, in the understanding of disease related to the use of alcohol, we would likely be in the same position today. As a matter of fact, most industries still treat the victims of disease from alcohol by disciplinary action only.

In 1931, Professor Haggard of the Department of Applied Physiology at Yale University instituted a long-range program of research into the many areas of medical and social science that are directly concerned with problem drinking. It is fortunate that such a study was initiated in an internationally famous University because the study of alcohol and alcohol addiction thereby acquired a new prestige in other centers. Had this work been undertaken in a small, little-known school, it might have been done quite as well, but the recognition of the work would have undoubtedly been delayed. The group at Yale University worked along very quietly for several years. There was no large body of recovered alcoholics available for study.

In 1935, the second important development came about. The organization known as Alcoholics Anonymous was formed. They had many difficulties at first, and by 1939 had only 100 members. Considering that the present membership is in excess of 140,000, the growth and success of this organization in the forties is without precedent. While the Yale Center of Alcohol Studies was identifying more and more of the basic scientific principles concerned in the use of alcohol and the development of disease from ethyl alcohol, the A.A. people were establishing an entirely new, successful method of treatment. In the early nineteen-forties, the Yale group and Alcoholics Anonymous began to compare notes and to assist one another. For example, for the first time there was available a large group of controlled alcohol addicts willing to collaborate in a clinical study, and a well-trained group ready to undertake such a study. Dr. E. M. Jellinec, now working on problem drinking with the World Health Organization in Geneva, undertook to identify the usual sequence of events in the development of addiction in large numbers of alcoholics. For the first time in the history of medicine, a clearer picture of what came first and what followed became established. The physician who took the trouble to study Dr. Jellinec's reports carefully, was put in a position of being able to predict from a small part of an alcoholic history what the rest of that history might be. For the first time, the physician was able to speak in language that the alcoholic himself could understand. The old saying that "only an alcoholic can understand an alcoholic" became less and less true. By 1945 and 1946, a new type of clinic came into existence based on the new knowledge which had largely been supplied by Yale University and by Alcoholics Anonymous. In the meantime, other schools and hospitals had contributed important knowledge of the understanding and treatment of this condition. The difficulties in older treatment methods became more obvious, and new clinics had a good opportunity to get started on the right foot.

One of the first medical groups to take an active interest in these new developments, was the Industrial Physicians. The late Dr. John Wittmer, of the Consolidated Edison Co., New York, pioneered in persuading his management that alcoholics were sick people, that they acquired their illness without their knowledge, that without proper help and treatment they would get worse, and that they deserved the same kind of consideration as other people employed by the company. As might be expected, he was severely criticized for this stand at first by many groups who had failed to acquire a new orientation to a very old problem. The Consolidated Edison Company is still one of the leaders in the recognition and management of this phase of industrial health. Their present program is being carried out under the capable management of Dr. S. Charles Franco.

The Allis-Chalmers Company in Milwaukee, Wisconsin, also pioneered in this work. They already had an extensive program of employee services. Accepting the fact that an alcoholic employee was a sick man, all of the services including legal advice, psychological assistance, loan fund, etc., were also made available to the alcoholic employee. A special A.A. Counsellor was retained to deal with this particular health problem. The results in the first two years exceeded the expectations of all who had planned the program. Valuable employees were saved for the company with a minimum of effort and expense.

The Dupont Corporation at Wilmington, Delaware, under the inspiration of their Medical Director, Dr. George Gehrmann, also retained an A.A. Counsellor for the medical services of the corporation. It was his responsibility to see that an A.A. group was formed wherever the Dupont Corporation had a plant. Again it was proven that the benefits of such a simple program

far outweighed any costs or trouble involved in setting it up.

Dr. John Norris, Medical Director of the Kodak Park Works, Eastman Kodak Co., Rochester, New York, was an active leader in this field. His policy was to encourage a general new community effort in the recognition and treatment of the problem drinker, utilizing all possible facilities, and by having the weight of the Kodak Company thrown behind the local community effort.

The Bell Telephone Company with Dr. W. H. Cruickshank as its Medical Director, has been a leader in Canada in this field of endeavor.

It is not surprising that industrial medical men were the first to use the new orientation in a practical and useful manner. More than any other physicians they were in a position to see the serious health, economic and social implications of disease from alcohol. Thus it is not surprising that the American Association of Industrial Physicians and Surgeons was the first organized group of medical men in the world to establish a committee on alcoholism. The first committee was formed in 1948, with Dr. George Gehrmann as chairman, and a special program was presented at the annual meeting in Detroit in April 1949. In 1949, Dr. Norris became Chairman of this Committee, and the second educational program was presented at the annual meeting in Chicago in 1950. In that year I had the honor of serving on this Committee, and I have had the additional honor of being selected as Chairman of this Committee in 1950, 1951 and 1952. Due to the efforts of Dr. Gehrmann and Dr. Norris, industrial physicians within this organization had an opportunity to listen to outstanding speakers dealing with the alcohol problem in a new way. In 1950 we decided to prepare a questionnaire to test out the interest of industrial physicians and their willingness to do something new. This questionnaire was prepared by the Yale Center of Alcohol Studies under the leadership of Professor Seldon Bacon. Somewhat to our surprise, the response to this questionnaire was greater than to any other questionnaire ever sent out by the central office in Chicago. Twenty percent of the 2400 members filled in the questionnaire carefully, and the group at Yale University made a careful study of the replies. Over fifty percent reported that they were called upon to deal with problem drinking as a condition for treatment, and over seventy-five percent reported that their opinions were sought in matters of policy in connection with discipline, severance, retirement, etc. Over ninety percent considered that there were problem drinkers in the plant who did not come to the attention of the medical department. Eighty percent reported that problem drinking had appeared among employees with five to ten years of adequate or superior work record, and over seventy percent reported that they encountered problem drinking in employees with over ten years valuable work record. Sixty-seven percent of the group wanted further education on alcoholism for use within their industry.

A Change of Name

In 1951 the name of the Association was changed to Industrial Medical Association, and the name of the Committee was changed to the Scientific Committee on Problem Drinking. The next stumbling block appeared to be a lack of any clinical coordination in approaching this problem. Much of the valuable work had been undertaken by scientists in various fields who made no attempt to coordinate the material in a way that might be readily used in any clinic. Some of the plans already in operation in industry did not readily lend themselves to re-application in a different industrial setting. Accordingly the Committee in 1951 concentrated on preparing a clinical orientation that might be readily understood and applied in industrial health departments. This work was done with the advice and guidance of Professor J. K. W. Ferguson, Professor of Pharmacology at the University of Toronto. No attempt was made in this orientation to come up with final answers. It merely consisted of an organization of existing facts and opinions into a potentially usable form in a clinical setting. At the annual meeting of the Industrial Medical Association in April 1952, this orientation was endorsed for clinical trial in industry by the Board of Directors of the Industrial Medical Association.

This year for the first time we have a large working committee of thirteen men, twelve for different zones of United States, and one for Canada and other I.M.A. members outside of United States. We are attempting to find out which industries would be interested in a new coordination effect on the part of industrial health departments in the recognition and management of problem drinking.

Conclusion

In conclusion, we feel that it is encouraging that this committee has grown until it is the largest working committee within the Association. It is no longer difficult to get capable men to work on such committees. Our efforts have the backing of the Managing Director and Board of Directors of the Association as a whole. We are justified in looking forward to a new enlightened era in the management of problem drinking in industry. It is particularly encouraging that more and more industries recognize problem drinking as a health problem and turn to their health services for advice concerning it.

Spotlight on the Health Centre

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Health services in industry were originally intended for the administration of first aid and emergency treatment only. However, the rapid industrial expansion of the past few years and the increasing awareness of the value of good health in the reduction of accidents and absenteeism have prompted many industries, especially the larger ones, to increase the scope of their medical service to include health appraisals, health education, employee interviews, and various other aspects of industrial health. The increase in scope of industrial medical service has necessitated a corresponding increase in size and a re-organization of the medical centre. Past experience has illustrated the importance of systematic long range planning in the designing of workrooms, elimination of hazards, job placement and many other factors which have a deciding influence on the success or failure of the industry. Since health is also a vital factor, it is obvious that the building or re-organization of a health centre will require special planning to ensure that it will most adequately serve its purpose, namely, the protection of the health of personnel. Such planning should include not only the acquisition of equipment, but also interior design, plans for future expansion, location, principal hazards of the industry, number of employees and many other important features. Close cooperation between management and health personnel will often avoid future alterations in design.

The following criteria for planning a health centre are based on actual experience and discussions with individuals familiar with industrial health planning.

Location

The most logical site for the health centre is near the mid-point of the plant area so that it will be equally available to all employees. This location will also permit the use of existing plumbing and electrical facilities and thus will avoid extra expenses. In hazardous industries, such as explosive plants, the centre should be located in a "safe area". An outside exposure is important to provide daylight for skin examination. Where possible, the area should be relatively free from noise and vibration which might interfere with examination procedures, and divert the patient's attention. Above all, the centre should not be used as a thoroughfare between departments. If possible it should be located near the Personnel Department to facilitate inter-departmental communications which involve the Medical Department.

Size

Ideally, plans should be made to allow for at least one square foot per employee (up to 1000 employees) in the over-all space. Allocation of treatment area should be based on type and number of accidents and work flow. Rooms should not be large and should be grouped compactly to eliminate unnecessary walking. The number of rooms provided will vary according to the number of employees, the hazards and the type of treatment accorded, but even smaller plants need at least three rooms, a waiting room, a treatment room with running water and adjoining toilet, and a quiet room which can be used as an examining room if necessary.

Exit and Entrance

The entrance passageway should not have any awkward turns and doors must be wide enough to permit easy passage of stretchers. If possible, allowance should be made for an ambulance entrance directly to the outside so that the injured person will not be exposed to fellow workmen. If the centre is on the second floor, an elevator will facilitate evacuation of stretcher cases.

Lighting

Incandescent or fluorescent lighting is adequate for general illumination. In addition, special incandescent lighting should be installed for examination of eyes, ears, nose, throat, etc. When the centre is being electrically wired, provision should be made for a sufficient number of outlets, including heavy duty outlets for equipment such as autoclaves and sterilizers.

Floor

Good flooring is essential in the health centre because it receives more traffic than most other plant offices. Tiling or inlaid linoleum are most practical for flooring, because they are both durable and easily cleaned. Since cleanliness is most important in the maintenance of surgical and medical aseptic techniques, care should be exercised when laying the floor and molding to be sure that there are no cracks or crevices to collect dust and dirt. A properly laid floor will reduce the work of the cleaning staff.

Walls and Ceilings

The material used in the walls and ceiling should be washable and painted according to a carefully chosen

color scheme. Soft greys, blues, and greens are very restful to the eyes and are less apt to show marks. Sound proof walls and ceilings are a great asset, especially if noisy plant operations are carried on above or around the health centre. Quiet surroundings tend to soothe the agitated patient and promote relaxation.

Ventilation

Air conditioning ventilation is ideal, but if this is not available, exhaust fans on outside walls will assist in the circulation of air. Temperature should be easily regulated and kept constant because fluctuating temperatures are conducive to shock.

Rooms

In plants where the volume of medical treatment warrants it, at least two quiet rooms with toilet and basin are necessary if both men and woman are employed. If space is limited, these may be used as examining rooms.

A doctor's office should be provided and equipped with hot and cold running water for hand-washing. If the doctor is employed on a part-time basis, the room may be used by the nurse for counselling and conferences. The nurse should have her own locker, toilet, and basin apart from those used by patients.

Furniture and equipment

Waiting Room

The waiting room should be equipped with a sufficient number of comfortable chairs or other seating facilities to accommodate the average number of patients. If smoking is permitted, ash trays should be provided and emptied frequently. Current magazines or periodicals placed conveniently on a table or in a magazine rack will serve to keep the patient occupied while awaiting his turn. A bulletin board displaying medical material such as health literature and posters should be placed in a conspicuous spot and attractively arranged.

Treatment Room

Since the nurse spends most of her time in this section of the centre, she should have her desk and chair located near the entrance from the waiting room. Her records may be kept in her desk, or if there is a large number of them, a filing cabinet may be necessary, and should be located within reach of her desk. Other equipment should include a sterilizer, a wash basin and perhaps a clean-up sink. If there are many treatments being carried out, an autoclave is a very practical item, because dressings and dressing containers can be sterilized and kept stored for future use. A foot-pedal sanitary pail, which can be easily cleaned, is essential for the disposal of soiled dressings, and other contaminated waste. A portable dressing carriage is desirable, but a stationary table will serve the purpose. Other necessary items of equipment include an adjustable stool, a chair with leg rest, a stretcher, and a mirror, A special eye shelf should be located in a space apart from other equipment, and work area, or if the eye care in the industry warrants it, a separate cubicle may be provided.

Recessed cupboards with sliding doors will present fewer ledges to collect dust. Shelves about 12 inches deep will accommodate the largest parcels kept in the cupboard and for convenience, materials not frequently used (such as extra blankets, basins, and sterilizing equipment for major accidents) should be kept on the top shelf, out of the way until needed. Such a cupboard can take the place of an expensive instrument cabinet; also, a part of it may be used as locker space for the nurse's off-duty clothing. Bracketed wall shelves will provide sufficient work space, and will eliminate the use of too many tables, which tend to clutter the room and complicate cleaning operations. Extra work space may be provided by a nest of tables which can be stored in a small space when not in use.

Since aseptic techniques are so important in the treatment of wounds, burns and infections, some provision should be made for scrubbing the hands. A very useful and economical piece of equipment for this purpose is a pedestal basin with a gooseneck mixing faucet and elbow-, knee- or foot-operated taps. It is also very satisfactory for cleaning wounds containing foreign materials such as grease, oil or dirt.

Since plant intercommunications are so important, the Health Centre should have telephone connections with all departments, as well as a direct line to the switchboard to speed up outside calls in case of emergency. Where there is a switch to other departments, the telephone in the nurse's office should have a cut-off, or buzzer, whichever is deemed expedient to the situation. A signal system connection with the outer office can save many steps for the nurse. If there is a full-time doctor, there should be an extension from the nurse's phone so that all calls will come to her first.

Quiet Room

This room should contain at least a chair, a cot, and a table. A portable desk and floor lamp are useful items if the room is used as an examining room.

Doctor's Office

If a doctor's office is supplied, it should be equipped with an examining table, a desk and chair, a telephone and a screened off corner, or separate cubicle to be used as a patient's dressing room. In order to conserve space, the examining table can be equipped with drawers underneath for storage of linen, gowns, rubber gloves and other necessary equipment.

Other Rooms

In large centres, an x-ray room with an adjoining dark room, and a laboratory may be included and the equipment provided will be dependent on the type of work carried out.

Staff

Although this subject has been left until last it is far from least important. Since the prestige and esteem of the health service is largely governed by the services rendered, it is necessary that particular care be exercised in choosing a medical staff.

The physician and nurse must be fully qualified, and have sufficient interest in their patients to win their confidence. They should be familiar with all plant operations, the hazards involved, and the most efficient methods of treatment of casualities; they should be capable of a sympathetic understanding and insight into the personal problems of employees both at work and in the home.

The staff of the Health Centre should have a knowledge of health education, sanitation, working conditions, accident and occupational disease prevention methods, and preventive health measures in general.

The value of a well organized and efficiently operated health service will be reflected in decreased absenteeism and accident rate, reduction in labor turnover, increased production, higher morale and greater job satisfaction. The effects may be carried over to the home as well: the employee who is satisfied with the treatment received at the plant Health Centre is more likely to encourage his wife and family to seek medical care in order to benefit from early diagnosis and preventive measures.

Every plant medical program must be designed to fit the needs of the plant in which it is to function, but the basic principles discussed here are common to most health centres, and are intended as a guide for those who are planning to set up or re-organize a plant medical service.

The Role of the Emission Spectrograph in Occupational Health Investigations

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Many occupational health problems arise from the industrial exposures of workers to inorganic materials. In the evaluation of the extent of specific exposures, the metallic and metal-like constituents of the inorganic substances are generally analyzed in dust or fume samples collected in the working environment. Oftentimes, the concentrations of the toxic atmospheric contaminants are relatively low and analysis of the sample becomes difficult for the analyst without a spectrograph. For the analysis of most of the inorganic constituents, comprising 70 or more metallic or metal-like elements, the emission spectrograph is uniquely suited. This instrument is used to characterize and measure the radiation emitted by specific elements.

All elements emit characteristic radiation when they are excited sufficiently by a source of energy. This source may be thermal or electrical. An example of the former is the well-known Bunsen flame used in elementary qualitative analysis for the excitation of the alkali metals to yield their characteristic flame spectra; a typical example of an electrical type of energy source is the spark, which is required for the excitation of such nonmetallic elements as selenium, sulfur or the halogens.

The most common source is the arc between graphite electrodes, the tips of which are maintained at incandescence by the electrical power of a direct current circuit. The sample is supported by the lower electrode and the materials contained in the sample are volatilized into the arc stream during the burning of the arc. During this process the metallic constituents of the sample become excited and give off radiation which is characteristic of the individual metals. This radiation can be sorted out into line spectra according to the individual wave lengths by an instrument known as a spectroscope.

This instrument which permits the observation of the line spectra in the visible region is now available in most college chemistry laboratories for students in qualitative analysis. An instrument which possesses a photographic attachment for the recording of these spectral lines is known as a spectrograph.

It possesses a specificity unparalleled by any other analytic instrument, and its sensitivity is far beyond that of most chemical procedures. It is excelled in sensitivity by very few techniques. As to precision, a deviation of two percent or less is no longer unusual in quantitative spectrographic procedures. For most purposes, such as analyses of atmospheric samples whose composition may vary widely from sample to sample, this is more than ample. Moreover, this precision is largely independent of the actual concentration of the metal or metalloid in the working range of the method.

From this standpoint of rapidity of application, the small amount of sample required for measurement and the low concentrations which can be detected (0.1 percent and less), the spectrograph is the instrument of choice.

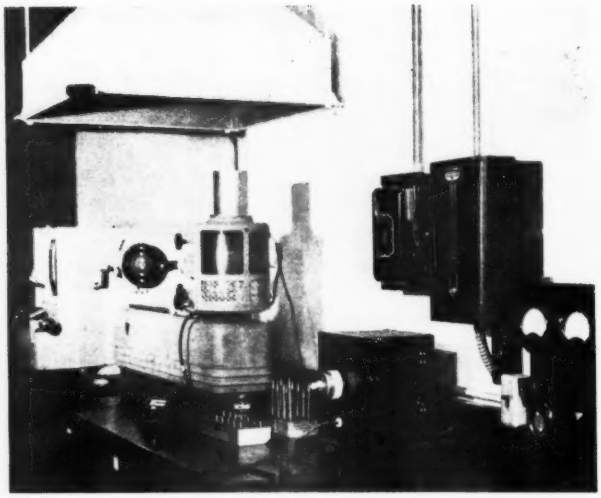

FIGURE 1: *The Bausch and Lomb large Littrow spectrograph is shown with the D.C. arc stand, and electrical control equipment. Bored graphite electrodes containing specimens for analysis and pencilled cathodes are in foreground. The canopy hood above the arc stand is for removal of toxic fumes and prevention of room contamination.*

The Division of Occupational Health has been employing spectrochemical methods of analysis to advantage for many years. In addition to applying those methods developed in the past, the staff continues research on newer techniques in spectroscopy. The following description of some of our developments and applications of spectroscopic techniques will demonstrate the support which these methods yield to our research and field investigations.

Semiquantitative Procedures.

Last year spectrographic analysis played a dominant part in an extensive investigation of atmospheric pollution in the Detroit-Windsor area by characterizing the metallic components of the air over this region. The analytic problem was the determination of as many metallic constituents as possible in the atmosphere as quantitatively as was consistent with time economy. Such samples were to be collected at 31 sites, covering the entire city of Detroit, and were to be taken continuously on a 24-hour basis over a period of six weeks.

In addition, there was the added demand that the information be supplied within a minimum period of time in order to assist future planning of medical, engineering, and statistical work for the entire investigation. More than 1,000 samples were involved. Inasmuch as it was anticipated that many of the metals would be present in low and trace concentrations and in view of the above-mentioned requirements a spectrographic procedure was the only answer to the problem.

Because time did not permit the development of quantitative procedures for each of the 24 metals to be determined, it was sufficient for the purpose at hand to develop a rapid semiquantitative procedure.[1] This consisted of a spectrographic exposure in a 220-volt d.c. arc and, after photographic development and fixing, the spectral lines of the individual elements were compared directly with those of a standard series in a Jarrell-Ash comparator-densitometer.

For this comparison a standard series of spectrograms were prepared from known and varied concentrations of each of 24 elements over the range of 0.25 to 200 micrograms. The lines chosen for the comparison of standard and sample spectrograms were selected judiciously so as to circumvent any possible interference such as the masking of trace element lines by those of the major constituents. The spectrograms were scanned rapidly for each element in turn in the series of samples on each plate, and the quantities corresponding to the matched standard lines were established almost instantly.

By this matching procedure the author was able to complete as many as 1,500 determinations per day. This is at least 30 times the best performance of a chemical analyst. The quantities of the individual metals represented in the standard spectrograms ranged from 0.25 to 40 micrograms for 13 of the elements, and for the remaining groups the ranges extended from 1.0 to 200.0 micrograms. The limiting factor in this study was found to be the time required for transferring and ashing the samples.

To evaluate the accuracy of this semi-quantitative spectrographic method, two of the elements of the group were analyzed chemically as well as spectrographically on a restricted number of samples. By this evaluation, the semiquantitative spectrographic method was shown to be fairly accurate, with an average deviation of eight percent for lead and 19 percent for iron, the latter element being present as a major constituent.

The foregoing represents one application of the spectrographic, semiquantitative techniques which are being utilized in this laboratory.

Quantitative Procedures

Quantitative spectrographic methods have also been employed to great advantage by this laboratory. Such methods have found special use for the determination of trace quantities of certain toxic metals in animal tissues from which is derived important information on distribution and excretion of metals by various routes of administration. For this work, quantitative methods have been extended in sensitivity down to a working region of 0.0005 percent in tissue ash, or 0.000005 percent in fresh tissues as liver, kindey, and lung.

The increase in sensitivity has been achieved by the use of lithium chloride buffer salt which suppresses both cyanogen band spectra and general background.[2] This buffer has the additional advantage of minimizing the mutual interference effects of major sample constituents by reducing their relative concentrations in

the arc. A further result is the increased volatility of trace elements by the carrier-action of the buffer system.

Another important way in which to gain quantitative accuracy is by the use of an internal standard. An ideal internal standard should possess the same spectral response as that of the element being analyzed. When this condition has been realized, the spectral lines of both the internal standard and the analysis element should be produced during the same period of the spectrographic exposure: and the unavoidable variations in arcing conditions should affect equally the lines of standard and unknown elements.

An example of such an internal standard is platinum which we use for the quantitative determination of beryllium in human and animal tissues. In this case, platinum produces its spectrum during the same period of exposure as that when the spectrum of beryllium is being formed. Another condition of quantitative spectrography is the use of constant developing conditions of the spectrograph plate. Plates are developed and fixed at 68°F.

In addition to the previous requirements, each photographic emulsion used for quantitative analysis must be calibrated to establish the photographic response. For this purpose, an iron arc is used in conjunction with an 8-step sector to establish the characteristics of the individual photographic emulsion.

The calibration of a single lot of plates is required every few months. One final condition is the maintenance of uniform electrode charges. This is done by keeping the concentrations of all elements constant in the electrode charge except the one being analyzed. Such charges consist of a combination of the metallic and nonmetallic elements in the sample or its ash, in any buffer salt used in the procedure, and in the added known quantity of the internal standard. Despite all of these seemingly involved precautions, the spectrographer can conduct with rapidity the quantitative analysis of samples.

FIGURE 2: *A comparator-densitometer, Jarrell-Ash Model 200. The spectographer is matching standard and sample spectrograms in the semiquantitative determination of metals. He was able to complete as many as 1500 determinations a day.*

As indicated above, one of the outstanding applications of quantitative spectrography in this laboratory is the determination of cobalt in animal tissues. The principles just discussed are employed in the development of the procedure.

The details of this method will be set forth in a subsequent publication, but it is of interest to mention here that these determinations are being conducted with an average deviation of about three percent on quantities of cobalt as low as 0.01 microgram in one-fifth of a gram of fresh tissue. The value of this procedure becomes more apparent when it is realized that the sensitivity of existing chemical colorimetric methods for cobalt is about 0.5 microgram, and that it is impossible to secure for the chemical analysis of cobalt sufficient tissue material, especially in the case of smaller animals such as mice.

Similarly, there has been no suitably sensitive chemical method for the determination of trace quantities of vanadium in animal tissues. Here again the spectrograph is being employed for the quantitative analysis of quantities of vanadium as low as 0.005 microgram in 200 milligrams of whole blood or fresh tissues. The accuracy obtained with the spectrographic procedure for vanadium approaches closely that cited for cobalt.

Other quantitative spectrographic methods have been developed as the needs of this laboratory demanded specific methods of greater sensitivity than those provided by current chemical methods. Perhaps the best example of these is the spectrographic method for beryllium. There is no other method of equal sensitivity or accuracy for the determination of the trace quantities of beryllium which are considered significant from an occupational health viewpoint. Other laboratories have similarly found the spectrographic analysis of beryllium a highly useful and sensitive method.[3,4]

The preceeding paragraphs have provided concrete examples of our current applications of quantitative spectrographic methods; others, equally good, might have been selected and, when occasions arise requiring determination of trace quantities of metals, new procedures will be developed.

Qualitative Procedures

Perhaps the application in which the spectrograph is most advantageously used is in the development of complete qualitative information on the metallic composition of a sample. Forty or more metals can be determined qualitatively with a single exposure with a medium size prism instrument, or in three exposures on a large Littrow instrument.

This procedure is being utilized in securing rapid information on the metallic constituents of the following materials: (1) Animal diets to detect the presence or absence of certain metals in the diet of control and test animals, (2) general specimens—discovery of unsuspected contaminants, (3) chemical reagents used for dermatologic investigations in which it is essential to know the presence or absence of certain skin-sensitizing metallic agents, (4) materials used as dust or fume sources in inhalation toxicity studies to determine their purity, and (5) miscellaneous variety of samples from field investigations to determine the nature of the toxic materials present.

Another application is the screening of samples for specific constituents prior to their chemical analysis. When these constituents are not detectable spectrographically, this screening automatically eliminates the necessity for chemical analytic determinations on such samples. An added advantage also in the analytic screening of samples is the identification of the other constituents which may act as interferences in a chemical procedure. This foreknowledge facilitates the proper choice of subsequent chemical methods with accompanying greater accuracy and time economy as a result.

Practical Considerations.

The presentation of the advantages and present accomplishments of our spectrographic procedures should not be made without mentioning a few reservations. Although once obtained, extremely rapid methods are possible, a considerable amount of time must be devoted to their development. The search for a suitable internal standard, for example, often taxes the resources of the spectrographer, but persistent search is usually well rewarded.

Another practical consideration enters into the qualitative measurements. Whereas it is true that a qualitative analysis for a few constituents can be made rapidly, complete qualitative analysis is not always a rapid procedure from which answers can be supplied forthwith. Blanket requests for complete qualitative examination of a specimen are examples of this sort. To conduct such an analysis, the spectrographer must adopt the attitude that (1) he may detect any metal in the sample, (2) he must prove to his own satisfaction that all the lines are accounted for, and (3) he must be assured that he has not mistaken a persistent line of a trace element for one of the weaker lines of a major or moderate constituent. For these reasons, a complete qualitative analysis is usually the most time-consuming type of spectrographic analysis.

Another matter of practical concern is the existence of mutual interference effects. Certain elements tend to suppress or enhance the spectra of other elements. For this reason, optimum exposure conditions demand a uniform matrix, referred to previously as the electrode charge, throughout the series of standard and unknown samples. In quantitative methods, it is desirable to employ a fixed mass of sample, the only permitted concentration variable being the analysis element.

Preparation of Samples

In our laboratory, although this is by no means true of all, the chemical preparatory work is done by the spectrographer. This is done because it is believed that a knowledge of the history of the samples, the type and the amount, provides a more satisfactory specimen for spectrographic analysis.

Summary

Some of the problems associated with the determination of trace quantities of metals in sample materials involved in occupational health studies have been mentioned. The advantages to be gained by the use of the emission spectrograph for metal analysis have been pointed out with specific reference to this Division's applications of the techniques of emission spectroscopy along with certain practical considerations for qualitative, semiquantitative, and quantitative analysis.

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